# Part 6- Session Papers for the EPA 23rd Annual National Conference on Managing Environmental Quality Systems

## April 13-16, 2004 Tampa, Florida

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# Spatial Modeling of Environmental Data I (Introductory)

Wayne Word and Arnold Gray, EarthSoft, Inc.

## Introduction

This workshop will focus on general electronic data management and spatial modeling concepts. Two-dimensional analysis of environmental data will be investigated using Surfer and ArcGIS.

For as long as site characterization/subsurface investigation data have been collected, the management and maintenance of those data have been challenging issues. In recent years, as laboratory analysis and field investigation techniques have evolved, the proliferation of such data has exacerbated the management and maintenance problem. The state-of-the-art and, arguably, the standard method of operation today is to implement an electronic data warehouse for managing such data.

An electronic data warehouse serves to assimilate, protect, analyze, and share data from the many disparate sources that may be involved in an environmental or subsurface investigation. Electronic data management for some facets of investigation, such as cone penetrometer tests and laboratory analyses, is nothing new (even though some analytical laboratories—albeit a decreasing number—still use archaic, outdated systems requiring manual notation or retyping of data). Electronic data managements systems are rarely implemented for a single purpose such as archiving historical data. The proper integration of data management with analytical and visualization tools can result in a turnkey solution that increases efficiency, reduces cost, and facilitates better decision-making through spatial modeling.

GIS technology integrates common database operations such as querying and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for documenting events, predicting outcomes, and planning strategies. Map making and geographic analysis are not new, but a GIS performs these tasks better and faster than the methods used by the few people who had the skills necessary to use geographic information to help with decision making and problem solving.

GIS has proven to be invaluable in subsurface site characterization. GIS has allowed users to better understand features such as the extent and concentration of contaminated areas, chemical fingerprinting to identify sources of contamination for nearby sites, soil and aquifer properties, groundwater flow direction and flow rates, and how they could contribute to adverse health risks to nearby residential or ecological receptors. This knowledge is often used to design an effective remedial system for the site conditions and to predict such a systems performance and its influences on the environment over time.

This workshop will introduce general data management and spatial modeling concepts for site characterization using integrated database queries, GIS visualization, contours and cross-tab labeling techniques. It will focus on two-dimensional modeling using ArcGIS, Surfer, LogPlot, Rockworks and related subsurface tools. A typical site will be assessed from data review to printed output suited for public and regulatory discussions. User friendly dialogs and menus will be demonstrated in the language of the chemist and geologist user.

Additional opportunity to review the products and procedures presented will be afforded following the presentation, or upon request at www.earthsoft.com.

**Agenda**

**8:30 – 8:45** **Introduction of Speaker(s)**
What is GIS and 2D spatial modeling of environmental data?
Why would I want to do 2D spatial modeling?
Do I have to be an expert to get started?

**8:45 – 9:05** **Introduction to GIS Visualizations**
Maps
Shape files
Interactive data queries

**9:05 – 9: 25** **Site Visualization using GIS interface connections**
Boring Logs
2D Fences
2D Contours

**9:25 – 9:45** **Data Mining using GIS database connections**
Generate Crosstab Contamination Summaries
Contour Principle contaminants
Show impact on sensitive receptors
Demonstrate Compliance status
Prepare output Visuals for demonstration or printouts

**9:45-10:00** **Questions**

# Spatial Modeling of Environmental Data II (Advanced)

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## Introduction

For as long as site characterization/subsurface investigation data have been collected, the management and maintenance of those data have been challenging issues. In recent years, as laboratory analysis and field investigation techniques have evolved, the proliferation of such data has exacerbated the management and maintenance problem. The state-of-the-art and, arguably, the standard method of operation today is to implement an electronic data warehouse for managing such data.

An electronic data warehouse serves to assimilate, protect, analyze, and share data from the many disparate sources that may be involved in an environmental or subsurface investigation. Electronic data management for some facets of investigation, such as cone penetrometer tests and laboratory analyses, is nothing new (even though some analytical laboratories—albeit a decreasing number—still use archaic, outdated systems requiring manual notation or retyping of data). Electronic data managements systems are rarely implemented for a single purpose such as archiving historical data. The proper integration of data management with analytical and visualization tools can result in a turnkey solution that increases efficiency, reduces cost, and facilitates better decision-making through spatial modeling.

One commonly used means of spatially modeling environmental data is a groundwater flow model. The establishment of a flow model is the basis upon which a chemical fate and transport analysis is founded. Understanding the underlying groundwater flow is also important in evaluation receptors when considering risk analysis. Pre- and post-processors for the numerous groundwater analysis models have made the application of these models to groundwater problems much easier and more intuitive. These tools often provide an interface wherein the modeler may easily delineate zones of constant head or no-flow, establish boundaries, and create input files required by the numerical code. However, the use of these modeling tools alone does not always provide a complete and correct answer to a groundwater flow problem. Powerful interfaces and compelling graphics do not eliminate the need to manage site-specific data obtained from field investigation and incorporate such data into the model.

GIS technology integrates common database operations such as querying and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. GIS has proven to be invaluable in subsurface site characterization. GIS has allowed users to better understand features such as the extent and concentration of contaminated areas, chemical fingerprinting to identify sources of contamination for nearby sites, soil and aquifer properties, groundwater flow direction and flow rates, and how they could contribute to adverse health risks to nearby residential or ecological receptors. This knowledge is often used to design an effective remedial system for the site conditions and to predict such a systems performance and its influences on the environment over time.

This workshop will build upon the general data management and spatial modeling concepts discussed in the Spatial Modeling of Environmental Data, Introductory workshop. It will extend from two-dimensional modeling to three-dimensional modeling using ArcGIS 3D Analyst and the Department of Defense Groundwater Modeling System.

Additional opportunity to review the products and procedures presented will be afforded following the presentation, or upon request at www.earthsoft.com.

**Agenda**

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|---|---|---|
| **8:30 – 8:45** | **Introduction of Speaker(s)**<br>What is 3D spatial modeling of environmental data?<br>Why would I want to do 3D spatial modeling?<br>What assumptions must be made?<br>(What's the hard work before you can have fun?) |
| **8:45 – 9:05** | **Solid Modeling in GMS**<br>Lithology Modeling, Stratigraphy Modeling, and GMS True Layer Data |
| **9:05 – 9: 25** | **Analytical Modeling in GMS**<br>Running a Transient Analytical Solution<br>Running a Static Analytical Simulation |
| **9:25 – 9:45** | **Spatial Modeling in 3D GIS**<br>Create 3D Features<br>Representing Analytical Data in 3D GIS Layers<br>Contouring<br>Export to VRML<br>Vector Map<br>Fly-through |
| **9:45-10:00** | **Questions** |

# PDQ OK!
# People Determine Quality Of Kourse!
# (the human factor and human nature of human capital in calculating environmental quality)

Don Sayre, Citizens Reclaiming the Ohop Watershed (CROW)
Steve Pruitt, Rainbow Consultants

*Abstract:*
*The primary goal of the EPA is for environmental programs and decisions to be supported by data of the type and quality needed and expected for their intended use. The Office of Environmental Information Quality Staff develops quality management practices and tools to enable individual quality systems to be planned, implemented, documented and assessed. Many quality system activities involving environmental data operations are inherently performed by personnel. Environmental data, whether from direct measurements or models, data bases or literature, is collected, compiled, and evaluated for decisions. (EPA Quality Manual for Environmental Programs, EPA Order 5360.1 A2). In every instance, the quality of the information relies in some way on the human factor and human nature of human capital.*

*This workshop openly discusses how the human factor is critical to data input and decision output for sustainability. It explores the influence of human nature on environmental quality using real life characterization of wisdom and folly within a managed watershed. It is an open forum on the human factor and human nature as undervalued human capital in quality systems and methodologies, uncertainty in measurements, innovations in quality tools and techniques and as educators for future sustainability indicators.*

*This workshop is an opportunity for participants to develop performance indicators for sustainability to be used by a watershed community. The CROW, Citizens Reclaiming the Ohop Watershed, is highlighted as a test case watershed community for three exercises: 1) Stretch existing environmental indicators to fit sustainability; 2) Scrunch sustainability indicators to fit a watershed world; and, 3) Sketch out benchmarks to calibrate a sustainable watershed community.*

*Source documents for sustainability indicators are provided for reference use; such as the EPA Index of Watershed Indicators; EPA Strategy for Water Quality Standards and Criteria; EPA Environmental Management System Implementation Policy; United nations Agenda 21; United Nations Millennium Declaration (Resolution 55/2); et al.*

*The workshop facilitators, Don Sayre and Steve Pruitt (Rainbow Consultants) are leading sustainable development in and for the Ohop Watershed, the heart of the Nisqually River Watershed from Mt. Rainier to Puget Sound, Washington State.*

# Overview of EPA's Quality Requirements for Solicitations and Contracts

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Holly Ferguson, EPA, Office of Research and Development
Nan Parry, EPA, Office of Research and Development

***ABSTRACT***[1]*: Over the last few years, EPA has been revising its quality-related policies for solicitations and contracts. This is a result of changes to the Federal Acquisition Regulations (FAR), new flexibility in contracting procedures such as simplified acquisition, and new types of contracting such as performance-based contracts. A workgroup of quality assurance (QA) professionals from across the Agency has been charged with updating the Agency's quality-related policies for contracts and solicitations to reflect these changes and take advantage of the new flexibility and procedures. This session will provide information on these changes, the required QA Review Form, the new Intranet site for guidance on the revised policies, and examples of the new flexibility allowed for documenting quality activities.*

## BACKGROUND

In 1999, the Federal Acquisition Regulations were amended to address higher-level contract quality requirements on a government-wide basis.[2] The new FAR contract clause at 52.246-11, *Higher-Level Contract Quality Requirement* (Feb 1999), allows a Federal agency to select a voluntary consensus standard as the basis for its quality requirements for contracts. The FAR contract clause also allows tailoring of the standard to more effectively address specific agency needs or purposes. Based on these FAR provisions, the Environmental Protection Agency (EPA) has selected ANSI/ASQC E4-1994, *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs*, as the foundation for its higher-level environmental quality requirements. Also, as permitted by the FAR, EPA has tailored this standard to ensure that Agency needs are met, for all activities involving the collection, generation, use and/or reporting of environmental data on behalf of EPA through the contracting process.

Due to these changes in the FAR, the EPA Acquisition Regulation (EPAAR) section 1546.2, *Contract Quality Requirements* (Mar 1984), which was a quality regulation that applied only to EPA, became unnecessary. On March 20, 2001, this EPA-specific regulation was removed along with its clauses (1552.246-70, 71, and 72) through a Direct Final Rule that was published in the Federal Register (65

[1] This abstract does not necessarily reflect EPA policy.

[2] FAR 46.202-4 contains guidance on when to use higher-level contract quality standards

FR 79781, December 20, 2000). The tailoring language allowed by FAR 52.246-11 and pertinent requirements from EPAAR 1546.2 are being incorporated into a revision to EPA Directive 1900, *Contracts Management Manual* (CMM). A procurement policy notice (PPN 01-02) was issued March 20, 2001 to ensure an orderly transition from EPAAR 1546.2 to the CMM. PPN 01-02 has been integrated into Chapter 46 of the new CMM. As of January 5, 2004, the revised CMM is still in EPA's Directives Clearance Process[3].

EPA's revised policy for quality in solicitations and contracts will be contained in Chapter 7 and Chapter 46 of the CMM. Basically, the following are used to ensure appropriate quality specifications are identified and implemented:

1. The QA Review Form is required for all solicitations and contracts, work assignments, delivery orders, task orders, and for modifications to existing work assignments, delivery orders, or task orders that involve a significant change to the Statement of Work. This form is designed to standardize how EPA Contracting Officer's Representatives and QA Managers communicate quality specifications to EPA Contracting Officers to ensure inclusion of the specifications in standard contract clauses.

2. The QA Manager assists with the development of the Technical Evaluation Criteria and any associated technical instructions for the Request for Proposal. The QA Manager serves on the Technical Evaluation Panel (when convened) if QA specifications are applicable to a procurement and:

   - the estimated value of the procurement exceeds $500,000; or
   - the estimate of the percentage of costs or level-of-effort allocated to activities requiring quality specifications exceeds 15%; or
   - procedures defined in your organization's Quality Management Plan apply.

3. The contractor develops (and implements) the appropriate documentation identified in the solicitation or contract statement of work (and reflected in the QA Review Form).

Step-by-step directions for implementing these specifications have been incorporated into the policy and an Intranet site has been developed to provide further guidance on implementation.

**THE QA REVIEW FORM**

The Quality Assurance (QA) Review Form (Attachment 1) is used to provide information to the

[3] Directives Clearance is the required review procedure before a policy can be issued or revised.

Contracting Officer on what quality specifications should be included in a solicitation and/or contract, and to provide EPA QA Managers with the information needed to oversee the quality-related activities of their organization's solicitations and contracts. It is important to note that the new form does not change the overall implementation of the EPA's Quality System. The Quality System will continue to be based on the ANSI/ASQC E4 consensus standard, and the process that EPA QA Managers use to ascertain applicable contract quality specifications will remain the same.

A QA Review Form must be completed by the EPA Contracting Officer's Representative for all actions shown above. However, technical directives and actions that do not affect the work performed by the contractor, such as incremental funding or time extensions, do not require a QA Review Form.

The QA Review Form in the CMM is the default form for both solicitations and all other contract Statements of Work. This form was designed to include all of the customary quality activities that are part of the Agency's QA System. However, tailoring (modifying) the QA Review Form is permissible, with the exception of Section III.b (Quality-Related Requirements) which corresponds directly to the standard clause that the Contracting Officer incorporates into a solicitation or contract. If an organization tailors the QA Review Form, the tailored form must be included in that organization's approved Quality Management Plan. If your organization does not tailor the QA Review Form, the form provided in Appendix 46.1D of the CMM must be used for all solicitations and contract Statements of Work.

**INTRANET GUIDANCE WEBSITE**

EPA has developed an Intranet website to assist EPA employees to determine the type of QA specifications needed for work under contracts ensure that acquired data are of sufficient quantity and adequate quality for their intended use. The website was created as an easy reference containing the necessary QA specifications and activities to be performed by Contracting Officer's Representations, QA Managers, and Contracting Officers. On this website, EPA QA specifications are broadly defined and cross referenced with the Federal procurement regulations for each type of contracting action that EPA uses to collect, generate, use, or report environmental data. At this session we will demonstrate and review the extensive information available on the website as well as answer any specific questions you may have.

**APPLICATION OF THE FORM WITHIN EPA'S QUALITY SYSTEM**

Section III.b of the QA Review Form is the section that standardizes the flow of information to the Contracting Officer. It can not be tailored by EPA organizations. The remaining sections of the form (which can be tailored) are designed to assist QA Managers in planning and implementing their programs. This session will focus on the proper use of Section III.b and how to take advantage of the form's flexibility in the application of the graded approach. Examples will be provided for the following:

- Solicitations for large, multi-project contracts,
- Solicitations for standard, single-project contracts,
- Solicitations for small, low-visibility projects requiring a “Joint Quality Management Plan/QA Project Plan,”
- Issuance of work assignments, task orders, etc.,
- Issuance of modifications to contracts, work assignments, task orders, etc.. and
- Statements of Work for which there is previously-approved quality documentation.

# Principles and Practices for Correct Sampling and the Impact on Statistical Data Quality

Patricia L. Smith
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*We present an overview of the Principle of Correct Sampling as defined by Pierre* Gy *(1992), including the delimitation, extraction, and handling errors due to incorrect sampling of solids, liquids, or gases. We give several examples for illustration. We then describe a simple sampling experiment and compare the accuracy and precision of different sampling methods. Finally, we discuss the impact on statistical data quality.*

## Overview of the Principle of Correct Sampling

Random sampling in the classical statistical sense means that every individual unit in a population has the same chance of being in the sample. This ensures that the sample mean is unbiased and has the smallest variance of unbiased estimates. Unfortunately, this definition does not work for bulk sampling (solids, liquids, and gases). The units of the lot are particles or molecules and thus can rarely, if ever, be accessed individually. Consequently, we take *groups* of particles or molecules, not individual ones.

While we talk about *samples* that are random, it is really only the *process* that determines randomness. Gy (1992) developed a random process for obtaining samples from bulk materials. His *Principle of Correct Sampling* has two parts.

- Every constituent element of the lot has the same, non-zero chance of being in the sample.
- The sample integrity is preserved both during and after sampling.

The first part addresses the *delimitation* (theoretical identification) and *extraction* (actual recovery) of the sample and is a generalization of statistical random sampling. The second part identifies an additional constraint for bulk sampling that we do not typically see in statistical sampling, namely, maintaining the chemical and physical properties of interest. This is often referred to as *sample handling.*

An example of both a delimitation and extraction error is the *sampling thief*, illustrated in Figure 1. It is designed to take a core sample of solid material either vertically (from a drum) or horizontally (from a bag). The pointed end is used to push through the material with the "windows" closed. Then they are opened to allow material to flow in at the different levels. After closing the windows, the thief is pulled out. Because of the point, material at the very bottom will never be in the sample. The thief therefore has a delimitation error. It also has an extraction error if the windows are not sealed properly, because material will start filling from the top before the thief gets all the way to the bottom. As a result, the thief does not follow the first part of the Principle of Correct Sampling.

Handling errors are typified by contamination or loss, either of a chemical or physical nature. Contamination can occur when the sample container is not clean, for example. In some cases, the container material itself may react with the sample contents. Evaporation and escaping dust are examples of loss. Negligence can also be regarded as a handling error, such as missing or mixed up sample labels, situations that can also occur with traditional statistical sampling. These errors violate the second part of the *Principle of Correct Sampling.*

**Sampling Experiment**

A simple sampling experiment using three different types of dried beans provides a good way to understand the practical difficulties of random sampling from bulk materials (Smith 2001). Lima beans, pinto beans, and lentils have different sizes, shapes, and densities, and they can be mixed in known quantities. Sampling can be done with several different methods. In this case, we used riffling, alternate shoveling, scooping, and the Japanese slab cake. Descriptions can be found in Gy (1992) or Pitard (1993).

Figure 2 shows the average bias by weight percent based on three subsamples (with replacement). Riffling has the smallest bias across all three bean types. Results for the variation, expressed in percent relative standard deviation, are shown in Figure 3 and are not as clear. Of these methods, riffling is preferred in principle, as long as the riffler is used correctly. Results from this particular experiment were performed by students in a sampling short course using rather crude tools and measuring devices.

**Impact on Statistical Data Quality**

The experiment above is unsophisticated, but the results agree with those of a set of controlled laboratory experiments by Gerlach, et al (2002), who assessed soil splitting protocols. They prepared and sampled known mixtures of sand, NaCl, and magnetite using sampling methods similar to those above. Riffle splitting performed the best, with approximate 99% confidence levels of less than 2%. “Grab sampling” using a scoop was the poorest method, with approximate 99% confidence levels of 100%-150% and biases of 15%-20%. These conclusions match what Gy’s theory predicts. The authors conclude that sample splitting inaccuracy can easily overwhelm field or laboratory analytical inaccuracy. Consequently, “producing results of appropriate quality for decisions concerning hazardous waste sites requires an evaluation of the sampling and subsampling inaccuracy.” Figure 4 gives results on variation for one set of experiments. The “Fundamental Error” shown in this figure is an estimate of the statistical variation that would result if the particles could be sampled one at a time and at random. It is thus the minimum variation that can be attained.

These experiments illustrate the important role that sampling methods play in bias and precision, but other factors influence statistical data quality as well. Sample size (weight or volume) also affects variation. If a certain precision is required, for example, then the larger the particles in the lot, the larger the sample size required (Gy, 1992). In their EPA Guidance Document based on Gy’s theory, Gerlach, et al (2003) illustrate the devastating effect a few large particles can have on estimation. When sampling for trace elements, Myers (1997) makes a distinction between the sampling *unit* and the sampling *support* (volume). The volume of an increment must be larger when the characteristic of interest occurs in trace amounts. Otherwise, not only will the statistical variation be higher, but large observed values may be perceived as outliers rather than as real occurrences. By integrating data quality objectives, Gy's theory, and geostatistical appraisal, Myers provides a guide for planning, sampling, estimating, and making decisions on projects. A review of this environmentally focused book is given in Smith (2001).

Our statistical data quality is only as good as the samples obtained and the data generated and reported by the analyst. Thus, in addition to describing their sample and data manipulation actions, Gerlach, et al (2003) suggest that statisticians and scientists describe the sample history and origin, if known. If we want small bias and small variation in our statistical estimates, we must pay attention to how our samples are obtained.

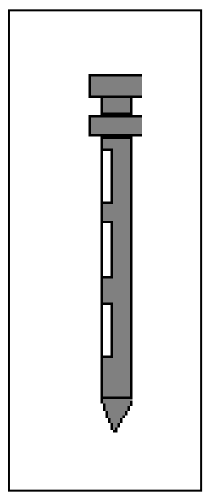

**Figure 1. Sampling Thief**

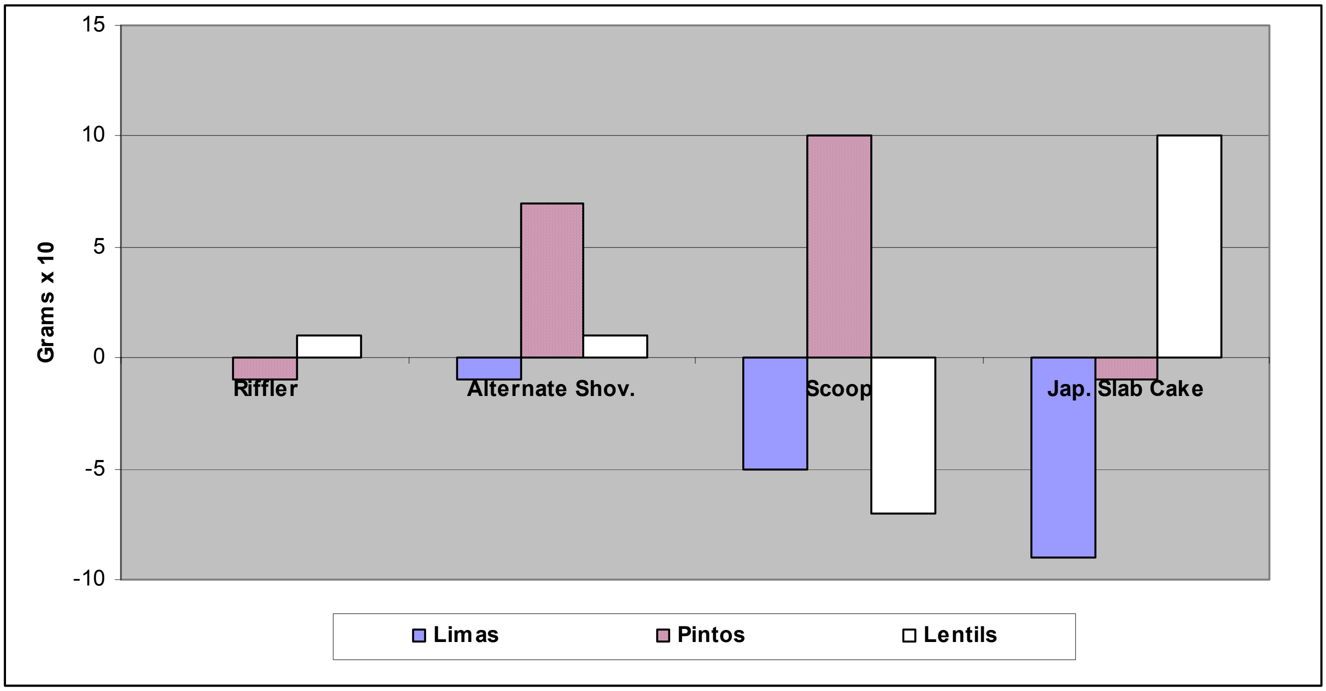


Figure 2. Average Bias for Bean Sampling Methods

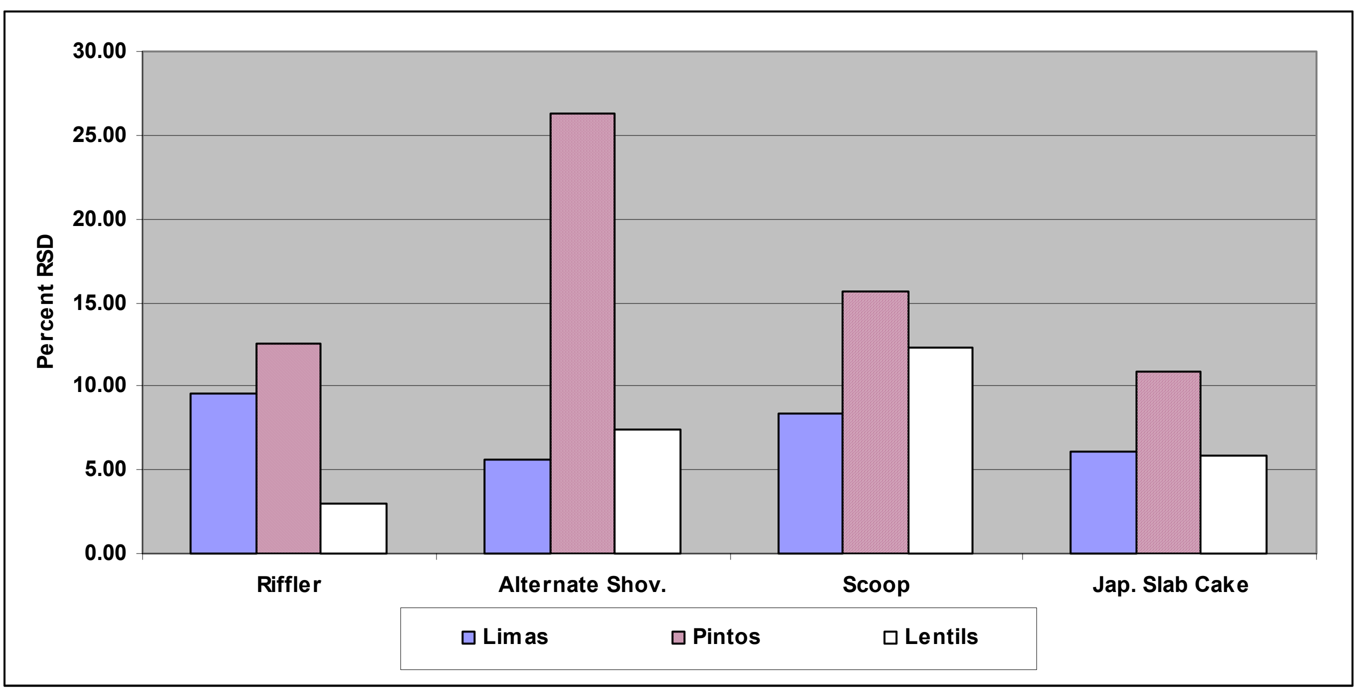

*Figure 3. Relative Standard Deviation for Bean Sampling Methods*

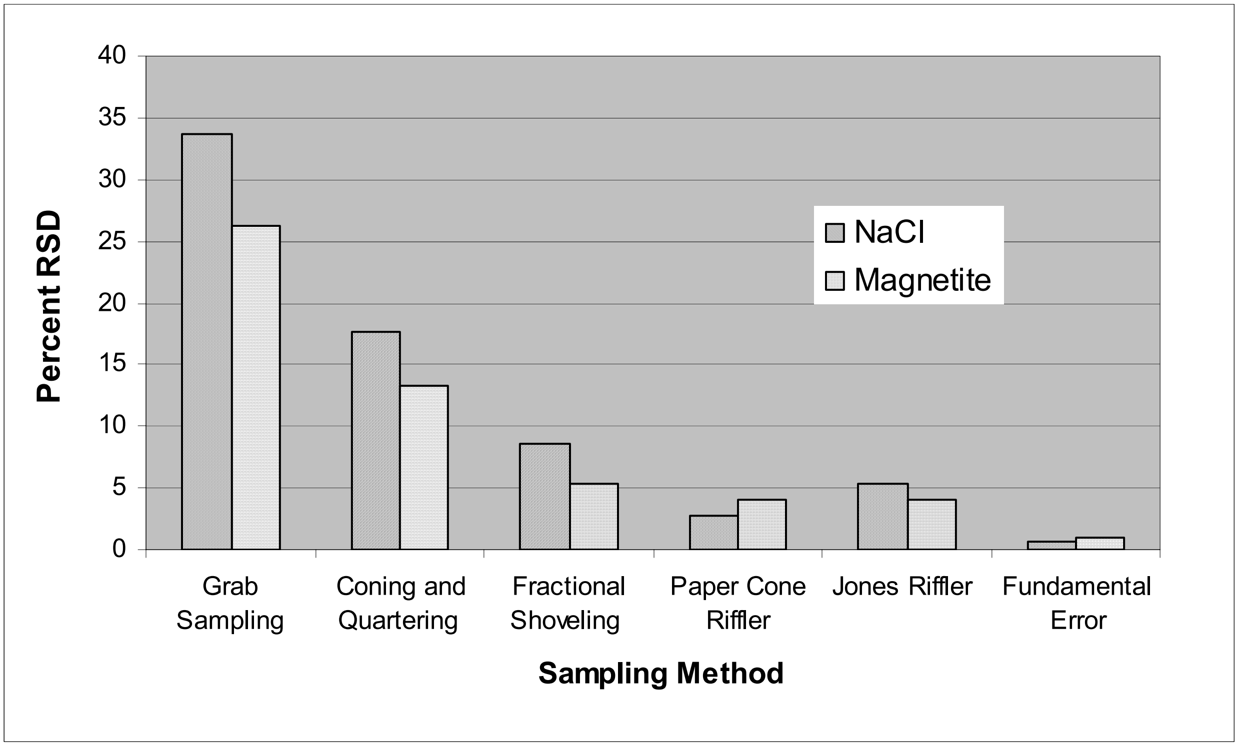


*Figure 4. Relative Standard Deviation for Soil Sampling Methods*

**References**


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# PRACTICAL APPLICATIONS AND BENEFITS OF ISO 9001:2000 TO CURRENT QUALITY MANAGEMENT SYSTEMS


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**1. Introduction**

1.1 ISO and the ISO 9001:2000 Standard
1.2 USEPA's Quality Assurance Technical Support Program
1.3 ISO 9001:2000 Principles Applicable to Quality Management Systems (QMS)

**1. Management Review**

2.1 Requirements of ISO 9001:2000, Section 5.6 Management Review
2.2 Inputs and Outputs
2.3 How to organize and conduct the Management Review
   2.3.1 Frequency
   2.3.2 Who participates
   2.3.3 Practical Tips for an Efficient and Successful Management Review
2.4 Benefits of Management Review

**1. Customer Focus**

3.1 Requirements of ISO 9001:2000, Section 5.2 Customer Focus
3.2 Customer Communication, Customer Feedback, and Quality Objectives
3.3 Corrections, Corrective Actions, and Non-conformance Reports
3.4 Continual Improvement/Preventive Action
3.5 Totally Electronic *Integrated Quality System (IQS)* Demonstration
   3.5.1 Introduction
   3.5.2 Database Software Application
      3.5.2.1 Automation
      3.5.2.2 Forms, Reports, Combo Boxes, Custom Menus and Tab Controls

3.5.3 Integration of Client Communications, Nonconformance Reports, and Client Satisfaction/Feedback Reports into One System
3.5.3.1 Monitoring and Measuring Client Satisfaction
3.5.3.2 Client Communication Log
3.5.3.3 Client Satisfaction/Feedback Documentation
3.5.3.4 Corrective/Preventive Action Reports
3.5.4 Attachments and Links
3.5.4.1 Attaching Related Documents and Communications to the IQS
3.5.4.2 Linking Communications and other Links
3.5.5 Approval, Routing and Notification
3.5.5.1 Using Login IDs
3.5.5.2 Integrating Microsoft Outlook with IQS for Internal Communications
3.5.6 Data Management
3.5.6.1 Entering, Archiving, Retrieving, Protecting and Evaluating Data
3.5.7 Tracking Reports and User Logs
3.5.8 Help Screens
3.5.9 Adapting and Customizing
3.5.10 Question and Answer

**1. Supplier Selection and Control**

4.1 Requirements of ISO 9001:2000, Section 7.4.1 Purchasing Process
4.2 Defining Critical and Non-critical Products and Suppliers
4.3 Initial Evaluation Criteria for Suppliers
4.4 How to Complete a Supplier Evaluation Form
4.5 Criteria for Addition, Annual Re-evaluation or Removal from Approved Supplier Lists
4.6 Effective Methods for Controlling Outsourced Processes/Suppliers
4.7 Benefits of Supplier Control

**1. Training Matrices and Training Effectiveness**

5.1 Requirements of the ISO 9001:2000, Section 6.2.2 Competence, Awareness and Training
5.2 How to Create Practical Training Matrices
5.2.1 Main Matrix
5.2.2 Required Reading Matrix
5.2.3 Health and Safety Matrix
5.2.4 OJT Matrix
5.2.5 Recurrent Matrix
5.3 How to Assess Training Needs
5.3.1 New/Modified Positions
5.3.2 Summary of Requirements
5.3.3 Updating Training Matrices
5.3.4 Maintaining Individual Training Records

5.3.5 Periodic Re-assessments
5.3.6 How to Develop a Training Budget
5.4 Effectiveness of Training
5.4.1 Demonstration of Training Effectiveness
5.4.2 Internal Audits

**Conclusions and Question & Answer**